The Integrator

Volume 10, No. 2 | Published by the Mission Services Program Office | July 2001

Features

The Long Duration Balloon Flies Again!

The National Scientific Balloon Facility's Long Duration Balloon Project (LDBP) utilizes the Space Network to relay data to investigators. The photo above shows the complete integrated LDBP payload in front of the hangar in Alice Springs, Australia. Prior to launch, engineers check out all of the various interfaces, satellite systems, science systems, power systems, etc.

Read more about this exciting project inside on page 11.

CODE 450 Mission Services Program

A Message from the Associate Director / Program Manager for Mission Services

As you peruse this issue of *The Integrator*, please notice that we have made significant changes to our publication. Most obvious are the revised appearance of our cover page, and the modernized "look" of the text and graphics. More important, however, is our new format—the sections in *The Integrator* now mirror the structure of the newly reorganized Code 450. Each project and office has a section containing articles devoted to its news and events. We implemented these changes to increase the ease with which readers access information in *The Integrator* and to improve readability.

With the advent of several recent appointments, our new organization's management team is in place (see the organizational chart below), and we are well-positioned to tackle the many challenges that lie ahead. In fact, we have already begun a strategic planning process that will ensure we can effectively meet our customers' needs in the coming years. The strategic planning team has developed mission and vision statements that will guide the direction of our organization.

MISSION STATEMENT

We provide our customers with space operations services and new technology to enable scientific discovery, research, and commercial space development.

VISION STATEMENT

We foster innovative technologies and provide management services to ensure cost efficient space operations for our customers.

As part of that strategic initiative, I would like to encourage all staff in the Mission Services Program to take advantage of available training opportunities. We need to "work smart," and guarantee that our skills and knowledge correspond to our changing role in the Goddard and NASA environments.

Our current activities and achievements are numerous. We are vigorously preparing for the launch of TDRS I, scheduled for this fall, and supporting the Aqua and ICESat missions, both scheduled to launch next fiscal year. Our organization continues to provide our customers with excellent levels of operational support. The MSP's safety record for this year is exceptional thus far—none of our approximately 1800 civil servants and contractors have suffered lost workday cases. I thank all of you for your outstanding contributions to these and other MSP successes, and am confident that together we are ready and capable to further NASA's mission in the coming months.

Phil Liebrecht

Phone: 301-286-5220
Fax: 301-286-1724
Email: Philip.Liebrecht@gsfc.nasa.gov

In This Issue ...

CODE 450

Mission Services Program

Education and Outreach in the Mission Services Program

Mission Services Program (MSP) participation in Education and Outreach (E&O) activities is on the rise. Both the number of people who participate and the number of different activities in which they engage are increasing. MSP managers, supervisors, financial analysts, engineers, and even our matrixed employees (from Codes 300, 500, and 700) are scheduling time away from the workplace to participate in a wide assortment of outreach events.

Last Spring, Phil Liebrecht, the Program Manager for MSPO, asked that a survey be conducted in Code 450 to find exactly what was being done in E&O over the last year. The results from the Code 452 Operations Services Project's Survey typify the variety of activities and the level of participation in the MSP. Code 452 personnel reported that they have taken part in:

- Career Day activities
- Local school science fairs
- Prince Georges County Science Fair
- Classroom Presentations (including Math, Science, Life Sciences, Aerospace, etc.)
- GSFC Community Days
- Mentoring programs at local schools
- Chairing and serving on school/faculty advisory boards
- On-site tours
- Summer Intern Programs.

In addition, MSP personnel participate in numerous other activities, including the ARISS (Amateur Radio on the International Space Station) and SAREX (Space Amateur Radio Experiment) programs. ARISS provides opportunities for school groups to communicate directly to the astronauts and cosmonauts on the Space Station via amateur radio during scheduled contact periods. SAREX (a joint program sponsored by NASA and the Amateur Radio Satellite Corporation) is currently phasing over to the ARISS Program.

Each of the outreach activities listed above entails time for planning and coordination, in addition to that required for actual participation. Code 450 can be rightly proud of its E&O accomplishments. We should also note, however, that no matter how much time is devoted to supporting these programs and activities, it is never enough. There are always needs unmet and programs not supported. So before we pat ourselves on the back, let us ask ourselves, "Is there something more that I could do to make a difference?"

By Hugh O'Donnell/GSFC Code 452 Emeritus

For additional information on E&O activities, or to volunteer your time, please contact the author via email (Hugh.B.ODonnell.1@gsfc.nasa.gov) or telephone (301-286-7684).

Mission Services Program's Web Site Evolves

We have begun construction on a reorganized Mission Services Program (MSP) web site that will reflect our new organization. The front page (also called the splash page) has been changed, and we are using an overall web site architecture similar to the one utilized by the Flight Program and Projects Directorate. We have regrouped existing information into the new Project structure, and are currently working on developing a new look for the TDRS Project (Code 454) web site. Work is also underway to update and reorganize the pages for the Operation Services Project (Code 452), the Technology and Upgrades Project (Code 453), and the Customer Commitment Office (Code 451).

Visit the MSP site at *http://msp.gsfc.nasa.gov/*.

Check us out! Constructive feedback is always appreciated.

By Lynn Myers/Code 453

For additional information, or to provide comments, please contact the author via email (Lynn.Myers@gsfc.nasa.gov), or telephone (301-286-6343).

Updated Mission Services Projects Schedule Included in this Issue

Please check out the Mission Services Projects Schedule chart located in the center of this issue. We have updated it to reflect current project schedules and events. Further updates will be provided in future issues of *The Integrator.*

CODE 451

Customer Commitment Office

Did you know that the MSP provides services to a wide variety of customers, including missions sponsored by:

NASA's Earth Science Enterprise

Terra
TRMM
QuikScat

NASA's Space Science Enterprise

HST
IMP-8
RXTE

Other Government Agencies

Landsat 7 (USGS)
Titan IV ELV (USAF)

International Space Agencies

TOPEX/Poseidon (joint with CNES)
International Space Station

...and more!

Landsat 7 Amasses Wealth of Data

Artist's rendering of the Landsat 7 spacecraft

During calendar year 2001, Landsat 7 has continued to extend its excellent operations record. Launched by NASA on April 15, 1999, the U.S. Geological Survey-operated mission collects detailed images of the Earth, creating a record of land cover and land use to help quantitatively monitor and evaluate the global ecosystem.

Repeating the same ground track every 16 days, the satellite's Enhanced Thematic Mapper Plus (ETM+) instrument works to systematically collect images while avoiding clouds. The amount of data gathered to date is staggering: 250 scenes representing 154GB of data are collected each day and downlinked to either the primary ground station at the U.S. Geological Survey's Earth Resources Observation Systems (EROS) Data Center in South Dakota, or one of two NASA Polar Ground Stations in Alaska and Norway.

As of June 18, 2001, 172,702 scenes had been collected and inserted into the U.S. archive. To put that number into perspective, consider that each scene covers about 185 Km. x 170 Km., or about 30,000 square kilometers. That works out to 7,500,000 Km^2 of Earth's surface per day. Given that, the 172,702 scenes in the U.S. archive represent 106 TB of data covering 5.2 billion Km^2 of Earth surface. Scientists, geographers, land managers and the public at large will spend years cultivating the treasure of information contained in these images.

By Steven J Covington/Aerospace Corp.

For additional information about Landsat 7, please contact the author via email (steven.covington.1@gsfc.nasa.gov), or via telephone (301-614-5211).

Landsat 4 Decommissioned

After a long and useful life, the Landsat 4 spacecraft has finally been decommissioned. The future of another of the Landsat satellites, Landsat 5, is now in question.

The Landsat 4 and 5 (L4/5) spacecraft were funded and launched by the U.S. Government, and then turned over to the Earth Observation Satellite Company (now called Space Imaging) to operate. In late February, Space Imaging notified the government that they no longer intended to operate the L4/5 spacecraft. Landsat 4 had lost most of its practical capability to transmit science data, thereby ending its useful life. Landsat 5, however, is still capable of delivering remote sensing data. After four months, L4/5 were transferred to the government, whereupon the decommission of the Landsat 4 spacecraft began.

Landsat 4 decommission was completed on June 15, 2001, when after several days of maneuvers, the spacecraft was shut off. The entire decommissioning procedure was designed to meet the NASA NMI guidelines for spacecraft End Of Life requirements, even though Landsat 4 and the USGS were not obligated to meet these requirements.

L4's nominal altitude is 705 km; its current altitude is 580km. The predicted re-enter period for L4 is between 8 and 25 years, meeting the NMI guidelines for a decay period less than 25 years. If we had not performed the decommissioning maneuvers, the decay period would have been 42 - 75 years. The Landsat 4 decommission process also met additional NMI guidelines requiring the depletion of onboard energy sources such as fuel and batteries, to avoid accidental explosion which would create a debris field.

NASA and the USGS worked closely to plan and execute the decommission activities, obtaining subcontractor support as needed. Space Imaging (the company that has been responsible for the welfare and operations of the Landsat 4 spacecraft) supported the decommission, as well as the Computer Sciences Corporation.

Landsat 5's future has not yet been decided. We are currently pursuing funding to maintain Landsat 5 operations but money has not yet been allocated. If funding is not obtained soon, L5 will be shut down as well. Stay tuned for more news regarding Landsat 5 in the next issue of *The Integrator.*

Information from Ron Smilek/Landsat 7 Flight Systems Manager

To learn more about the Landsat program, visit the Landsat Program homepage at http://geo.arc.nasa.gov/sge/landsat/landsat.html.

Expendable Launch Vehicle Update

Let the music begin! Sea Launch successfully placed the XM "Roll" satellite into orbit on May 8, completing the "Rock" and "Roll" complement of XM digital radio satellites. As mentioned in the last edition of *The Integrator*, XM Satellite Radio Inc. plans to offer "state-of-the-art digital audio radio directly to XM-capable radios in cars, homes and portable radios anywhere in the United States" via these two satellites. This fee-based service should be available to customers later this summer. More details are available at *http://www.xmradio.com.*

This summer will be a busy one for Expendable Launch Vehicles (ELVs), with many important payloads scheduled for launch. NASA is scheduled to launch the Microwave Anisotropy Probe (MAP) and the Genesis solar wind sample return spacecraft on Delta II vehicles in June and July. Atlas II will launch several spacecraft, including NOAA's Geostationary Operational Environmental Satellite M (GOES-M) in July. Sea Launch heads

(continued on page 8)

Photo taken June 26, 2001, at Cape Canaveral Air Force Station, shows workers at the top of the rocket on launch pad watching as one half of the fairing cover is moved into position around the MAP spacecraft which will be launched on a Delta II ELV.

(continued from page 7)

back to sea in July for a Galaxy 3C mission, and Titan IV is scheduled to launch another Defense Support Program satellite for in late July.

NASDA, one of our new Space Network customers, plans to resume its H-II program with the launch of an upgraded H-IIA vehicle in August. The H-IIA program will use Tracking and Data Relay Satellite System (TDRSS) resources to support a demonstration in-flight test during the summer of 2003 and the SELENE (SELenological and ENgineering Explorer) mission to the moon in the summer of 2004. Planning for these two missions is well under way with our latest Technical Interchange Meeting (TIM) occurring in March.

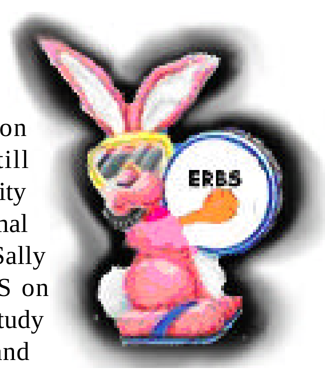
Boeing passed a major milestone at the end of May with the delivery of the first production Delta IV common booster core (CBC) to Cape Canaveral Air Force Station in Florida, where it will be used to validate the new Boeing launch facility. The CBC will be used for Pathfinder Tests to check out processing operations and launch pad certification. The first Delta IV launch is scheduled during the spring of 2002.

CNES/Arianne-5 personnel attended a second TIM held at Goddard on June 6. TDRSS will be used to support Ariane-5/ Automated Transfer Vehicle (ATV) missions starting in 2004. Nine ATV launches to the International Space Station are planned between 2004 and 2014. A demonstration flight is planned for 2003. Ariane-5 is launched from Kourou, French Guiana.

By Joe St. John/Lockheed Martin

For further information, please contact Ted Sobchak via telephone (301-286-7813) or email (Ted.Sobchak@gsfc.nasa.gov).

ERBS – It Just Keeps Going and Going!



(Image property of Eveready Battery Company, Inc.)

Sixteen years, eight months and over ninety one thousand orbits since launch, the Earth Radiation Budget Satellite (ERBS) is still providing the earth science community with valuable atmospheric and thermal radiation budget data. Astronaut Sally Ride (STS-41G) deployed ERBS on October 5, 1984. Its mission is to study how solar radiation is absorbed and re-emitted by the earth, and to investigate the global distribution of atmospheric aerosols such as ozone and nitrogen dioxide. These factors are principal drivers of the earth's weather patterns.

Artist's Rendering of the ERBS satellite

Originally planned as a two-year mission, ERBS has been operating well past its designed lifetime. This extended mission has resulted in both hardware and software challenges for the Flight Operations Team (FOT). At launch ERBS had two healthy 22 cell, 50 amp-hour NiCd batteries. The satellite is now operating on a single battery with only 19 functioning cells. This situation necessitates the charging of the battery via constant current commands, plus orbit to orbit monitoring of the battery's state of charge, pressure and temperature. At least 60 power commands must be uplinked from the ground by the FOT on a daily basis.

New Telemetry And Command (TAC) Pentium III computers operating on a WinNT 4.0 platform have recently replaced the original PDP-1134s (installed in 1979). The Applications Processors (AP) that the new TACs interface with are still the original PDP-1170s (also installed in 1979). Due to this eclectic mix of old and new technologies, the FOT must carefully tune the TACs so that they do not overwhelm the APs with their vastly greater native processing speed.

In addition, a new off-line trending system based on a UNIX operating system platform running on Sun workstations has also recently become operational. This new system greatly expedites the analysis of Electrical Power Subsystem telemetry data, permitting the FOT to perform required battery charging adjustments within a single orbit.

A 180^0 yaw maneuver is performed ten times per year to keep the sun angle power positive with respect to the solar arrays. On June 14, 2001 ERBS successfully performed its 169^{th} yaw maneuver. The ERBS orbital plane is oriented four times per year so that the sun is in direct line of sight for almost the entire orbit. Twice per year the depth of these "full sun" conditions requires loadshedding modifications to be made to the normal battery charging procedures. On June 29, 2001 ERBS began its entry into a deep full sun period, which peaked on July 5. As in past full sun events, the FOT carefully monitored and adjusted the battery charging to maintain the required charge and state of health.

As ERBS continues its atmospheric and earth radiation budget investigations, the FOT will support the ground system and science communities through the careful maintenance of ERBS onboard systems and the continual improvement of all of our processes.

By Douglas King/HTSI

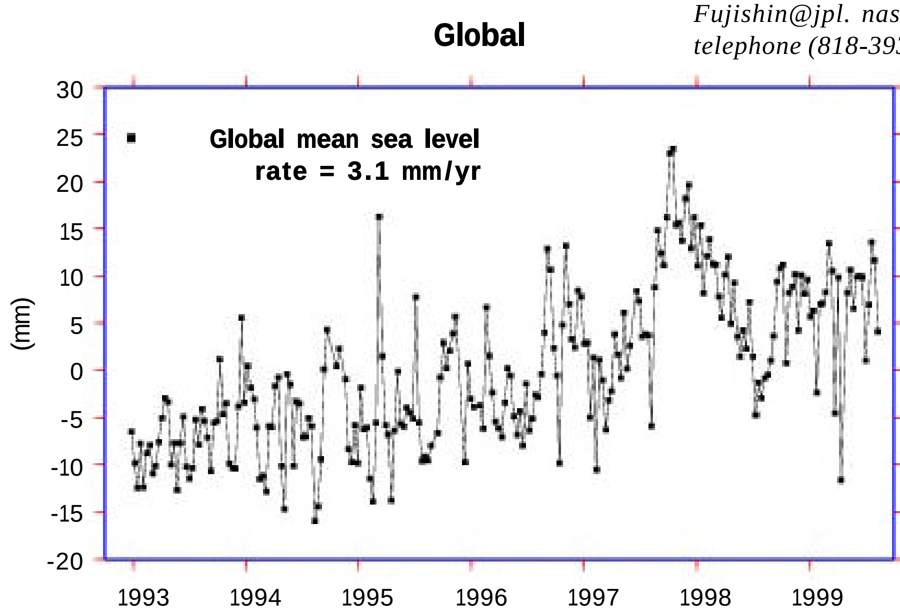
For further information please contact the author via telephone (301-286-2152) or email (douglas.king@ csoconline.com).

TOPEX/Poseidon and Global Warming

The U.S.-French TOPEX/ Poseidon satellite continues to operate well as the mission approaches its ninth anniversary in August. Over this time period, the satellite radar altimeter has measured global sea level with unprecedented accuracy and precision. This data set has allowed scientists to better study long-term sea level change, which has recently been a subject of considerable interest relative to studies of global warming.

Measurements of long-term increases in global mean sea level are considered by many to be an indicator of global warming, which may be caused by increases in atmospheric “greenhouse” gases. There are essentially two methods for measurement and determination of long-term sea level variations. Prior to satellite altimetry, global sea level change estimations were derived from tide gauge measurements. Recent estimates of global mean sea level rise from tide gauges range from 1.7 to 2.4 mm/yr. Satellite altimeter measurements are now utilized to provide improved measurements of global sea level variations, especially over shorter periods.

Calibration of the TOPEX/Poseidon radar altimeter is crucial for determining the accuracy of individual altimeter measurements. Several methods of cross-calibration have been utilized throughout the mission. First, an onboard internal calibration is periodically performed to monitor any degradation of the radar instrument itself. Satellite altimeter measurements are also monitored from independent in situ verification sites. NASA maintains such a calibration site on the Harvest oil platform off the coast of southern California, and CNES (the French Space Agency) operates a site on Lampedusa Island in the Mediterranean Sea. Perhaps most critical to the process are altimeter calibrations calculated from a global network of lake and ocean tide gauges. Sea level measurements from satellite altimetry and tide gauges have different limitations, so both are necessary for the most complete picture of sea level change.



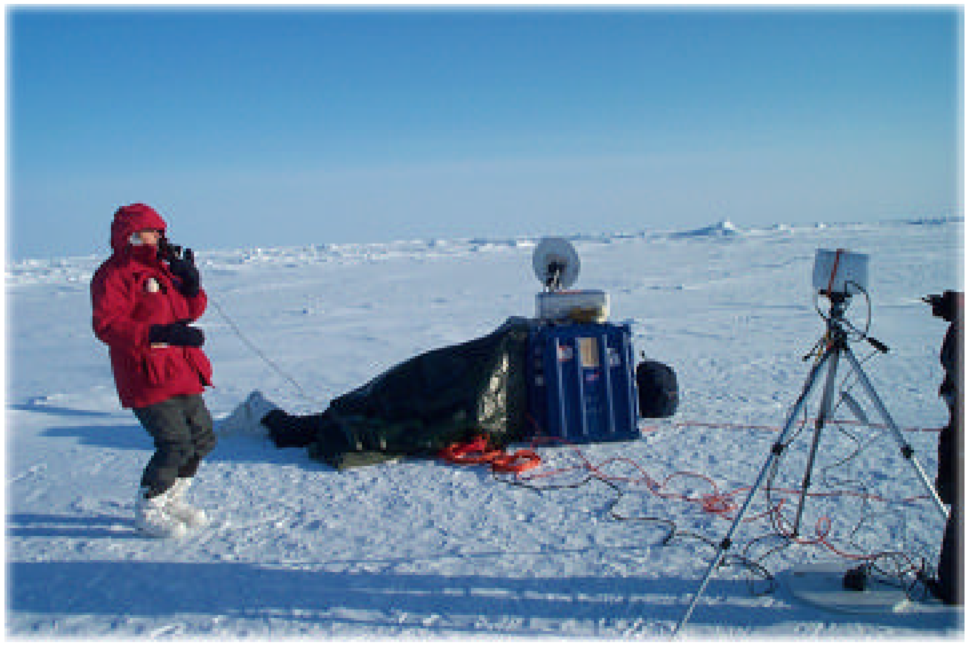
This graph depicts temporal variations in global mean sea level computed from TOPEX/ POSEIDON over the period from December 1992 through August 1999. Each dot is a single 10-day estimate of global mean sea level. A correction for drift in the TOPEX Microwave Radiometer has been applied, and the data have been corrected with a tide gauge calibration.

Because global warming and its associated effects occur over relatively long time periods, data from the TOPEX/ Poseidon satellite essentially become more valuable and informative as the mission continues. Jason-1, the follow-on mission to TOPEX/ Poseidon, will enable scientists to continue monitoring global warming and sea level variations well into the next decade. Like TOPEX/ Poseidon, Jason-1 is part of an international partnership agreement between NASA and the French Space Agency, CNES, and is scheduled to launch in the fall of 2001.

By Mark Fujishin/Manager, JPL Earth Science Mission Operations

For additional information on this project, please contact the author via email (Mark.D. Fujishin@jpl. nasa.gov), or telephone (818-393-0573).

TILT Supports Unique North Pole Expedition



Dr. Kathy Clark, NASA Chief Scientist for Human Exploration, utilizing TILT to communicate from the North Pole

In response to requests from U.S. Senator Stabenow (D-MI) and NASA Headquarters, Code 450 personnel and resources recently supported a team from the WomenQuest organization during their expedition to the North Pole. WomenQuest encourages and enables women to pursue challenging careers that may involve extreme environments. WomenQuest sponsored this polar expedition—the first all-woman trek to the North Pole. The trip originated on April 14, 2001 at a Russian ice station north of Siberia. From there the women skied all the way to the geographical North Pole, arriving on April 24.

NASA accomplished support of the expedition through the "You Be The Scientist" educational outreach program, which was originated at GSFC by Mike Comberiate. Through this program, NASA created a mission sponsored by the Earth Observing System (EOS) Program to support the polar trek and its associated outreach program. NASA team members voyaging to the North Pole included Mike Comberiate (Code 422); Chris Morris (Code 422); Kevin Ballou (Code 566); Dr. Kathy Clark, NASA Chief Scientist for Human Exploration (NASA HQ); Dr Gunther Kletetschka (NASA Geophysicist); Ken Anderson (Aqua Instrument Systems Manager); and Andre Fortin (Code 566). Team members working behind the scenes included Dave Israel (Code 567) and Dave Beverley (Code 422).

The NASA team provided a live Internet web cast of the women when they reached the North Pole using the TDRSS Internet Link Terminal (TILT). In addition, we performed a series of educational web casts (also via TILT). These web casts enabled students to participate in "virtual field trips" during the NASA team's long journey to and from the North Pole. We conducted several web casts involving geology and earth science during our excursion, allowing students and teachers from the U.S. to interact with mission scientists.

Our arrival at the North Pole permitted us ample time to set up TILT for the dramatic arrival of the women, who skied from the Russian side of the arctic. The WomenQuest team members were in excellent spirits as Dr. Kathy Clark interviewed them, asking her own questions, and questions from literally hundreds of people who had submitted them earlier via the Internet. Senator Stabenow conducted a telephone conversation (via the Code 450 Iridium phone) with the WomenQuest Expedition leader at the North Pole. Their conversation was also broadcast with excellent clarity on the web cast. During her conversation, the Senator voiced her appreciation for the NASA support of the WomenQuest expedition.

By Andre Fortin/GSFC Code 566

Please visit these Internet sites to learn more about the following subjects:
TILT: msp.gsfc.nasa.gov/pet/tilt.htm
The NASA team's North Pole trip: http://coolspace.gsfc.nasa.gov/northpole2001/
WomenQuest: womenquest.org/

The Long Duration Balloon Flies Again!

The Long Duration Balloon Program (LDBP) flew two very successful science missions from McMurdo Station, Antarctica last winter. The ATIC (Advanced Thin Ionization Calorimeter) payload was launched on December 28, 2000 and was terminated on January 13, 2001. The ATIC payload studied Galactic Cosmic Rays. The TopHat payload launched on January 4, 2001 and was terminated on January 31, 2001. The Tophat flight lasted just short of 27 days. That flight was the longest zero-pressure balloon flight executed to date. Tophat is an unusual science payload in that its instrument sits on top of the balloon. It weighed about 500 pounds, and scientists used it to study the Cosmic Microwave Background Radiation. Both payloads were recovered and the science groups are now analyzing their data. The flights were a complete operational and scientific success! More information about ATIC can be found at *http://spdsch.phys.lsu.edu* and TopHat at *http://topweb.gsfc.nasa.gov*. Both science groups utilized TDRSS to send a good portion of their data in real time.

Photo of the LDBP payload taken during a pre-launch hang test. The hot air balloon in the background is owned by a private company that specializes in providing rides to paying customers.

This photo shows the small tow balloon that is inflated first to pick up the bigger balloon top plate which holds the electronics that control the pressurization of the bigger balloon when it reaches float altitude. Inflation of the bigger balloon then begins and the tow balloon is released when the bigger balloon can support the top plate electronics.

LDBP also attempted two flights from Alice Springs, Australia at the beginning of the year. These flights were to test the new Ultra Long Duration Balloon (ULDB) vehicle. These balloons are the largest super-pressure balloons ever flown (approximately 18 million cubic feet), and can carry up to 2200 pounds of scientific experiments for up to 100 days. More information about the ULDB vehicle can be found at *http://www.wff.nasa.gov/~uldb/index.html*.

The first ULDB flight carried the NIGHTGLOW experiment, which included telescopes that measure the ultraviolet glow of the Earth's atmosphere. The Motorola 4th generation TDRSS transponder was also flown for the first time on this balloon flight. All of the NIGHTGLOW scientific data was to be relayed in real time through TDRSS. Unfortunately, the first super-pressure balloon failed to reach float and was terminated. There are plans to re-fly NIGHTGLOW in the near future from Australia, Alaska, or possibly Sweden. More information about NIGHTGLOW can be found at *http://lheawww.gsfc.nasa.gov/docs/gamcosray/hecr/NightGlow/ng.html*.

The second ULDB flight successfully tested the super-pressure balloon for one diurnal cycle. Project personnel have plans to build more of these balloons in the near future, incorporating improvements learned from these flights to improve reliability.

The LDBP expects to execute two flights in Antarctica in December 2001. One will be a reflight of the BOOMERang payload which will measure finer temperature fluctuations in the Cosmic Microwave Background, and one will be the TIGER (Trans-Iron Galactic Element Recorder) payload (*http://cosray2.wustl.edu/tiger*), which will measure Galactic Cosmic Rays above the 300 Mev range.

By Bryan Stilwell/NSBF/Physical Sciences Laboratory, NMSU

To learn more about this project, please visit the web sites listed above, or contact the author via email (stilwell@master.nsbf.nasa.gov), or via telephone (903-723-8097).

International Space Station Early Communication System—End of an Era

The International Space Station (ISS) Early Communications (ECOMM) System was activated for communication support in December 1998 during STS-88 mission activities. Since then, ECOMM has logged over 12,000 hours of support. During the STS-100/ISS 6A mission last April, however, ECOMM was deactivated. For the GSFC Team involved with ECOMM, the news of the deactivation caused us to reflect upon the project's past. In previous editions of *The Integrator* there were several articles concerning the ECOMM system, following this system from development, through testing, into implementation, and finally operations

The ISS Program solicited GSFC help to develop a quick and inexpensive transceiver able to provide early ISS communication capability prior to core system readiness. The Mission Service Program played an essential role in this endeavor by utilizing an existing transceiver developed by an internal research and development project led by ITT Industries (formally Stanford Telecom). After two years of design, development, and test activities, the ECOMM System activation occurred on December 10, 1998 during STS-88.

The ECOMM Transciever

ECOMM was originally intended to be a short-term communication solution. Because of ISS build delays, however, ECOMM served as the primary means for US communication for more than two years. The system provided early command and telemetry control support of the ISS in the first months of operations, before astronauts were onboard. During the early habitation period, ECOMM provided voice, video, and control communications. ECOMM achieved all of this despite the fact that the system had a low return data rate of 20.48 kbps, a high data rate of 128 kbps, and a forward rate of 6 Kbps!

From a GSFC perspective the ECOMM story is a testimony of team dedication and mission success. The GSFC ISS Test Team and Space Network Operations personnel demonstrated effective management of resources, time, and technical knowledge to provide ground to space communications with the ISS. A shining example of "Better Faster Cheaper" has come to a successful end.

By John Smith/LM and Doug Lumsden/LM

For additional information, please contact Ted Sobchak/GSFC Code 453 via telephone (301-286-7813) or email (Ted.Sobchak@gsfc.nasa.gov).

Preparations for Aqua Are Underway

CSOC is supporting preparation activities for the Aqua spacecraft launch, currently scheduled for no earlier than December 20, 2001. Aqua utilizes the Space Network (SN), the polar ground stations of the Ground Network (GN), and the Earth Observing System (EOS) Data and Operations System (EDOS) that CSOC operates and manages for NASA. The SN stations at the White Sands Complex (WSC) and the GN stations have new support requirements which require software and hardware modifications. As a result, MSP staff and contractors are actively working to update, test, and verify new functions to support the Aqua mission.

When Aqua launches, EDOS will become a multimission support facility, performing science data processing for Aqua and the already operational Terra spacecraft. CSOC personnel have been performing acceptance testing of the new EDOS software and

Artist's Rendering of the Aqua Spacecraft hardware capabilities provided by the developer (TRW). They are also assisting the ground facility staff with mission readiness testing and preparing for launch readiness testing.

Preparations for Aqua also required new IP network interfaces to be installed, affecting the SN, GN, and EDOS interfaces. A joint team of CSC, CSOC, and LM staff recently accomplished system testing, acceptance testing, and preparation for operations of the new interface provided by NASA. Although the IP network interface was required for Aqua, the Terra mission has transitioned its current operations to this new interface.

In addition, GSFC's Network Control Center and Flight Dynamics personnel continue to provide premission test support, as the Earth Observing System Operations Center (operated by LM) prepares for Aqua flight operations.

The CSOC team will continue to work closely with our customers and fellow contractors as the countdown to Aqua launch proceeds.

By Teresa Murray/CSOC/EOS Customer Services Representative

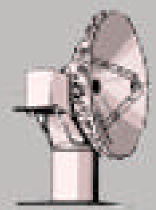
For additional information, please visit the Aqua web site or contact the author via email (teresa.murray@csoconline.com or telephone (301-805-3333).

Visit the Aqua web site at http://aqua.gsfc.nasa.gov

Other prospective MSP customers include:

Aura
Swift
ICESat
HESSI
ADEOS-II

Watch for updates on these and other potential customers in future issues of The Integrator!



CODE 452

Operation Services Project

Network Control Center News

The Network Control Center (NCC) has significant operational accomplishments and several ongoing Data Services Management Center (DSMC) related activities to report for this issue of *The Integrator.*

Our operational activities are proceeding very well. From February 1, 2001 to May 31, 2001, the NCC supported seven Expendable Launch Vehicle launches and three Space Shuttle missions.

NCC staff delivered NCC Data System (NCCDS) software release M00.3 to operations on February 20, 2001 (see adjacent article on NCCDS maintenance for more details).

The NCC Security Plans for the Service Planning Segment Replacement (SPSR) and Communications and Control Segment (CCS) were approved by the SERB and signed. The NCC Contingency Plan was also approved and signed. Both of these documents address concerns/recommendations that resulted from the audit by the Office of Inspector General.

NCC personnel are also actively working to ensure that the transition of the NCCDS to the DSMC at the White Sands Complex (WSC) progresses smoothly. This move entails re-hosting two NCCDS components—the CCS and the NCC Test System (NTS). For a description of both of these complex efforts, please see the adjacent article on the NCCDS.

The NCC transitioned the STDN Daily Report (SDR) responsibilities to the WSC Operations Shift Supervisor (OSS) in early June.

WSC personnel received extensive orientation and familiarization instructions at the NCC on Flight Dynamics Facility products and the NCC-98 system, from April 12th through the 20th.

NCC staff members are currently evaluating the amount of floor space that will be available after the DSMC transition, to determine whether consolidation of other facilities into the Building 13 complex is feasible.

Finally, Mr. Greg Coombs (NCC Lead Technical Manager) received notification that he was selected for the Space Flight Awareness Award. He will be traveling to Florida to view the STS-104 Shuttle launch. Congratulations Greg!

By Joseph Snyder/ATSC

For more information, please contact Bill Webb/GSFC Code 452 via email (bill.webb@ gsfc.nasa.gov) or telephone (301-286-3264).

NCCDS Maintenance Status and Future Plans

Network Control Center (NCC) personnel promoted the third maintenance release of NCC Data System 98 (NCCDS 98), dubbed Release M00.3, to Operations in February 2001. This release is the final component of the initial series of NCCDS maintenance releases. This series of releases focused upon increasing system stability and performance. The releases were completed in preparation for the transition of the NCCDS to the White Sands Complex (WSC), where it will become the major component of CSOC's Data Services Management Center (DSMC).

NCCDS preparation for the move to WSC also included re-hosting the Communications and Control Segment (CCS) and the NCC Test System (NTS) to more appropriate hardware platforms.

The CCS re-hosting effort replaced the current VAX 8550 platform with a VAX 6610, which is a platform more compatible with the existing WSC VAX equipment. NCC personnel have successfully integrated the first VAX 6610 cluster into the System Test suite and tested it. This cluster was then shipped to WSC to become the prime CCS cluster of the DSMC. They then integrated the second and final cluster into the Auxiliary NCC (ANCC), and completed its Operations Evaluation Testing (OET). This new platform is scheduled to transition into NCC Operations in late June 2001.

The NTS Porting effort is similar in purpose to the CCS Re-host: it is necessary to migrate to a platform that is more effective for the DSMC. The new NTS system is now undergoing OET. Personnel using this system truly appreciate the results of the porting effort—the system is now more integrated, and entails a more customer-friendly Java interface. This new interface makes the NTS increasingly intuitive to use, which is tremendously important in the DSMC, since the test personnel there have not utilized this system before. The OET team is currently certifying the test system, and this effort should be completed in late June or early July.

The re-hosted CCS baseline also served as the starting point for the implementation of NCCDS modifications for use of Ka "Wide Band" Phase 2. This release, CCS Release M01.2, required modifications to both the VAX component and the HP component of the CCS. These modifications were developed and delivered to System Test in April 2001, and System Testing of these changes was completed in May 2001. These changes will be verified by the OET team in July 2001, and are scheduled to become operational in the NCCDS by August 2001. The NCCDS will then be capable of fully supporting the Ka "Wide Band" demonstrations planned for later this year.

The influence of the DSMC project has become much more visible in the NCC recently. The most significant impact has been the complete dismantling of the test and training (T&T) equipment suite. This set of equipment was packed and shipped to WSC for the initial buildup of the DSMC operational network. This "teardown" limits all of the testing of the NCCDS software to the ANCC suite. In addition, DSMC Project Management responsibilities were transitioned from CSOC Central in Houston to GSFC. This change has sparked some additional planning, potentially including another NCCDS maintenance release.

By John Russell/CSC

For additional information, please contact Bill Webb/GSFC Code 452 via email (bill.webb@gsfc.nasa.gov) or telephone (301-286-3264).

National Association of Broadcasters Tests HDTV Through Space Network

Radio Frequency Simulations Operations Center (RFSOC) personnel recently contributed to a "cutting edge" technology proof-of-concept test by providing the test bed and TDRSS relay interface to the National Association of Broadcasters (NAB). This testing, which took place in April of this year, demonstrated that High Definition Television (HDTV) can be transmitted successfully through the TDRSS network. The ultimate goal is to provide HDTV services for the astronauts onboard the International Space Station (ISS) via the TDRSS Ku-band forward and return links.

In order to prove this concept, Dave Beering (a consultant for NAB) along with Fred Frey and Fred Gams of Honeywell Technology Solutions Inc. (HTSI), effected a very elaborate test setup at the RFSOC. The return link consisted of the following setup. The HDTV data transmission of 155 Megabits per second (Mbps) originated at the Naval Research Laboratory (NRL) in Washington, D.C. and traveled by optical fiber to the RFSOC via Building 28 at GSFC. The output of the NAB-supplied fiber optic modem modulated (8-QAM) a 140-MHz intermediate frequency, which was then upconverted to Ku-band (15 GHz) and radiated to TDRS using the RFSOC's 3-meter antenna.

(continued on page 16)

This photo shows the 3-meter dual S-Band/Ku-Band antenna at the RFSOC that was used during the HDTV "Proof-of-Concept" testing.

(continued from page 15)

At the White Sands Complex (WSC) the process was reversed, with WSC downconverting and demodulating the HDTV data, and NAB then retransmitting it through a commercial satellite link to the NAB trade show in Las Vegas, NV, as well as other locations within the continental United States. The TDRSS links through the RFSOC worked flawlessly throughout the three-day trade show, thereby demonstrating the viability of the proposed concept to provide HDTV services for the ISS using the Space Network (SN).

By James A. Braun/HTSI

For additional information, please contact Fred Gams/HTSI via telephone (301-286-8564) or email (fgams@pop500.gsfc.nasa.gov).

Future testing of the HDTV through TDRSS from the RFSOC may employ the 5-meter Ka-Band antenna system (shown at right) with its accompanying 3-meter Ku-band antenna.

Ground Network Commercialization Efforts Continue

The last issue of *The Integrator* (March 2001) introduced you to planning activities for commercialization of NASA's Ground Network (GN). In the past three months, NASA, CSOC, and our commercial service providers have been extremely busy putting those plans into action.

On May 24, CSOC briefed a detailed GN commercialization plan to the Space Operations Control Board (SOCB). The SOCB is a senior decision-making forum within NASA. Any significant changes to the space operations architecture or customer support infrastructure must be approved by the SOCB. In the May 24 briefing, CSOC staff described an evolutionary approach to GN commercialization.

The approach includes three major architectural elements (or subnetworks): a polar segment, a mid-latitude/equatorial segment, and a third segment supporting one-of-a-kind or unique requirements. Examples of unique requirements include IMP-8 support (requires VHF), Space Shuttle launch and ascent at MILA/PDL and along the East Coast, TDRS station keeping (a ranging requirement), and ADEOS-II (a Japanese spacecraft with mission-unique equipment currently installed at Wallops). The planning document is specific with respect to the polar and mid-latitude segments. Additional planning and analysis will be required to provide commercial service solutions for the mission-unique requirements.

The polar segment consists of Tracking, Telemetry and Command (TT&C) antennas at Svalbard, Norway; Poker Flat, Alaska; and McMurdo Station, Antarctica. The SOCB approved the CSOC plan to consolidate and commercialize the operations in Svalbard with the Norwegian firm, Space Data Services (SDS), as the preferred commercial service provider. SDS will provide services on a price per pass basis using the Svalbard Ground Station (SGS), the commercially developed SKS station, and potentially a third eleven meter system being installed this summer on Svalbard by Tromso Satellite Station. The Norway transition will be completed this summer.

The second commercial consolidation for the polar segment is at Poker Flat, Alaska, with Honeywell DataLynx targeted as the preferred commercial service provider. Eleven meter (or high rate) services will be provided from both the Alaska Ground Station (AGS) and the Honeywell DataLynx PF1 station. The Poker Flat LEO-T (5m) system will also transition to a commercial service provider, but no decision has been made regarding a provider for that system. The aging Transportable Orbital Tracking Station (TOTS) system will be decommissioned for orbital support, but may be retained to support suborbital launch campaigns.

There are no plans at this time to conduct any commercial activities at McMurdo.

With the Triana spacecraft in storage, the GN commercialization plan calls for much of the mid-latitude and equatorial support to be moved to sites provided by Universal Space Networks (USN). USN also has a number of collaborative service providers around the world, providing redundancy and robustness for this architectural segment.

In conjunction with all of this activity, we will decommission some older systems at Wallops Island, and move support requirements from Wallops to commercial service providers in each of the three segments. It is anticipated that the entire commercialization process will take 2-3 years to complete.

Although the SOCB approved of the overall plan, there is a caveat: CSOC and NASA Goddard must return to the SOCB with specific implementation plans for each proposed transition. Accompanying these plans must be a detailed business case for the GN commercialization, along with risk analyses.

The bottom line is that commercializing the GN has two primary objectives: first, meet or exceed operational support standards, and second, reduce the overall cost of operations. If there is not a strong business case for overall GN commercialization, or if the risk to high quality customer support is too great, we will not shift support requirements to commercial service providers just for the sake of commercialization.

Stay tuned as CSOC and NASA move forward in the execution of this plan.

By Bill Brooks/Windermere ITS

For more details, contact the author via email (wbrooks@witusa.com).

WIND Spacecraft Successfully Pioneers Distant Prograde Orbit

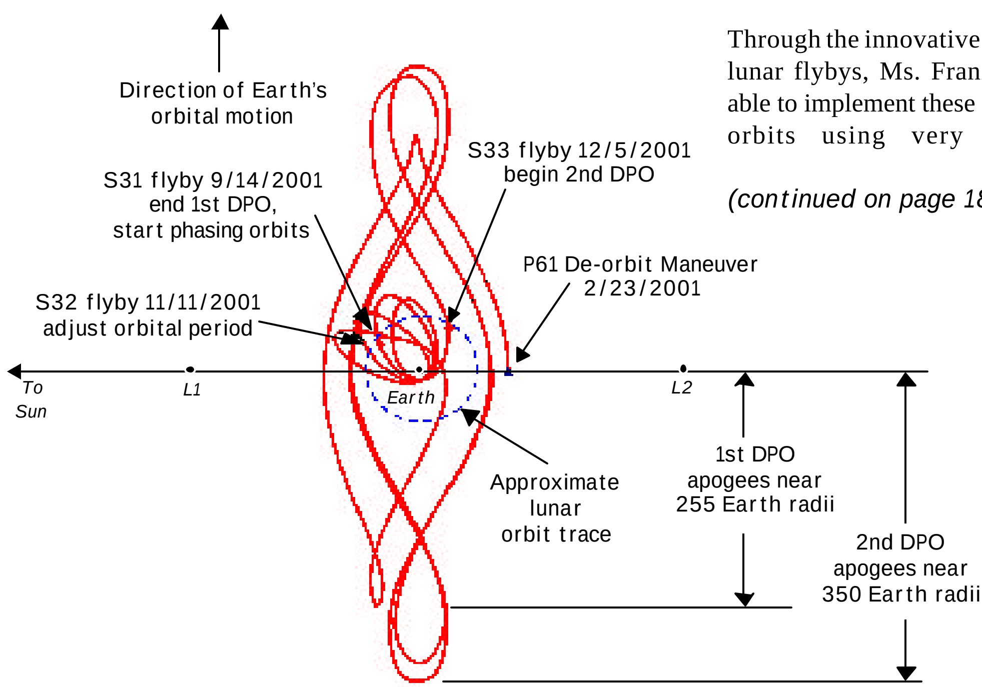
The WIND spacecraft was launched in November 1994 on a three-year mission to study the solar wind and its interaction with the Earth's magnetosphere. Now, over six years later, the GSFC-managed WIND is still going strong, returning valuable data to Earth from regions of space above and beyond its original trajectory profile. Following the spectacularly successful lunar backflips in 1999 and 2000 (see the March 2000 issue of *The Integrator*), WIND has made space history again, by becoming the first spacecraft to fly in a Distant Prograde Orbit (DPO).

WIND entered its current DPO with the spacecraft's 32nd lunar gravity assist flyby in August 2000. In the DPO–a periodic solution to Hill's formulation of the restricted three-body problem–spacecraft apogees alternately lead and trail the Earth in its orbit about the Sun, allowing the sampling of the solar wind in regions previously unexplored by other space missions. In this configuration, WIND is making plasma and magnetic field measurements together with the Advanced Composition Explorer (ACE) spacecraft at the Sun-Earth L1 libration point and the Geotail spacecraft in its 9 x 30 R_E geocentric orbit. By sampling these three areas simultaneously, scientists can study highly structured and rapidly evolving regions of geospace over very large-scale lengths. In addition, with WIND positioned far from the Earth-Sun line, it can track Coronal Mass Ejection (CME) events from the Sun to the Earth and thus serve as a precursor to NASA's STEREO mission, planned for launch later this decade.

WIND's DPO was established through an intricate series of lunar flybys and spacecraft propulsive maneuvers designed by Heather Franz of Computer Sciences Corporation, the WIND flight dynamics analyst in the Flight Dynamics Facility. As seen in the orbit diagram, WIND's current orbit will allow measurements of the solar wind up to 1.6 million kilometers ahead of and behind the Earth. Another complex series of lunar flybys and phasing orbits this Fall will terminate the current orbit and send WIND into a second, larger DPO, with apogees as far as 2.2 million kilometers ahead of and behind the Earth.

Through the innovative use of lunar flybys, Ms. Franz was able to implement these exotic orbits using very little

(continued on page 18)



WIND's first and second Distant Prograde Orbits
(ecliptic plane projection in rotating coordinates)

(continued from page 17)

spacecraft fuel. In fact, the entire WIND mission could be regarded as a case study in the use of lunar gravity assists to achieve trajectory profiles that would be impossible through reliance on propulsive maneuvers alone. Through careful optimization of WIND trajectory designs, Ms. Franz constantly strives to minimize the amount of fuel used, thus maintaining WIND's unique flexibility to explore novel orbit configurations and obtain new science data in the future.

By Mali Hakimi/CSOC Flight Dynamics manager

For more information contact Heather Franz/Flight Dynamics Analyst via email (hfranz@csc.com) or telephone (301-286-2475); or Bob Dutilly/ISTP Mission Director via email (rdutilly@pop500.gsfc.nasa.gov) or telephone (301-286-4916).

Flight Dynamics Personnel Implement First of a Kind Spacecraft Maneuvers

The Advanced Composition Explorer (ACE) is one of three NASA spacecraft stationed at the L1 libration point of the Sun-Earth/Moon system, and is in a so-called "halo orbit" about that point. ACE's orbit differs from those of other L1 missions, because the frequencies of motion in and out of the ecliptic plane are unique. For ACE's relatively small-amplitude orbit, the different in-plane and out-of-plane frequencies result in a continually evolving trace as viewed from Earth (see Figure 1). ACE's special case halo orbit is called a Lissajous orbit.

Since orbits at the L1 point are inherently unstable, both halo and Lissajous orbits require station-keeping maneuvers to maintain the desired motion. Due to communication constraints, halo and Lissajous orbit missions generally involve a Solar Exclusion Zone (SEZ), defined as a cone with apex at the Earth and axis along the Earth-to-Sun line. The spacecraft must keep away from the SEZ to avoid interruptions in science and housekeeping operations caused by the Sun's interference. What is peculiar

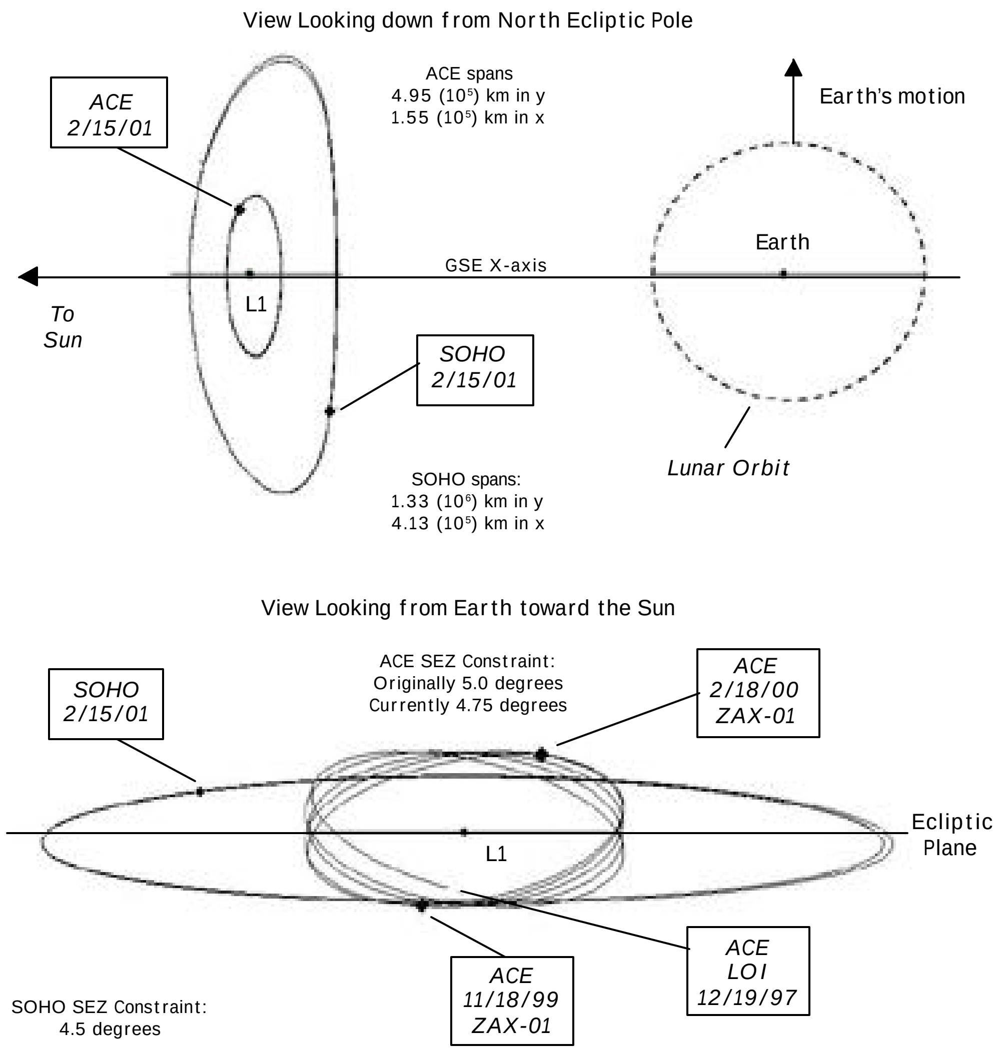


Figure 1. A comparison of SOHO's halo orbit with ACE's Lissajous orbit (L1-centered Rotating Libration Point Coordinates)

to ACE's Lissajous orbit is that it would eventually degrade so that it crossed directly in front of the Sun as viewed from Earth, if it were allowed to evolve naturally (see Figure 2).

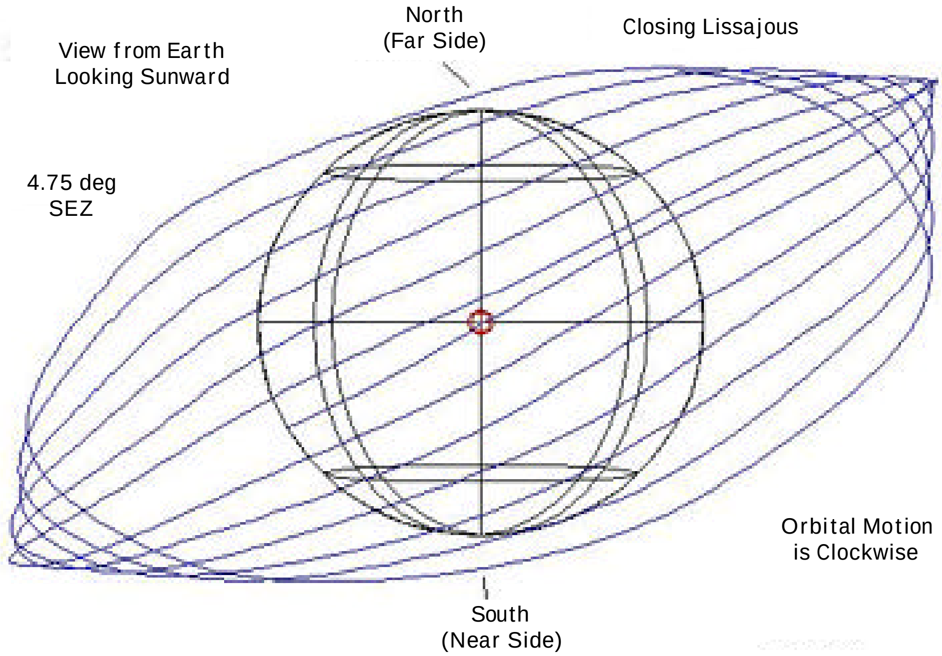


Figure 2. ACE's Lissajous Orbit Evolution as Viewed from Earth
(L1-centered Rotating Libration Point Coordinates)

Theoretical work on how to control the out-of-plane motion of Lissajous orbits by implementing Z-axis delta-V impulses to preclude entering the SEZ has existed for several decades. These theories had never been put into practice for any mission, however. Craig Roberts of Computer Sciences Corporation (CSC), the ACE flight dynamics analyst in Code 450's Flight Dynamics Facility, planned the first ACE Z-axis control maneuver in November 1999 when ACE's orbit evolved to the point that SEZ transits were imminent.

This maneuver kept ACE from passing into the SEZ, and marked the first time such a Lissajous orbit control scheme had been implemented for a space mission. Beginning in February 2000, Flight Dynamics personnel began performing similar Z-axis control maneuvers once during each Lissajous orbit revolution, or approximately every 6 months (See Figure 3). This work has verified that the previously theoretical method of Lissajous orbit Z-axis control could be implemented for a real-world operational mission.

By Mali Hakimi/CSOC Flight Dynamics Manager

For more information contact Craig Roberts/Flight Dynamics Analyst via email (croberts@csc.com) or telephone (301-286-4165); or Bob Sodano/ACE Mission Director via email (rsodano@pop500.gsfc.nasa.gov) or telephone (301-286-6506).

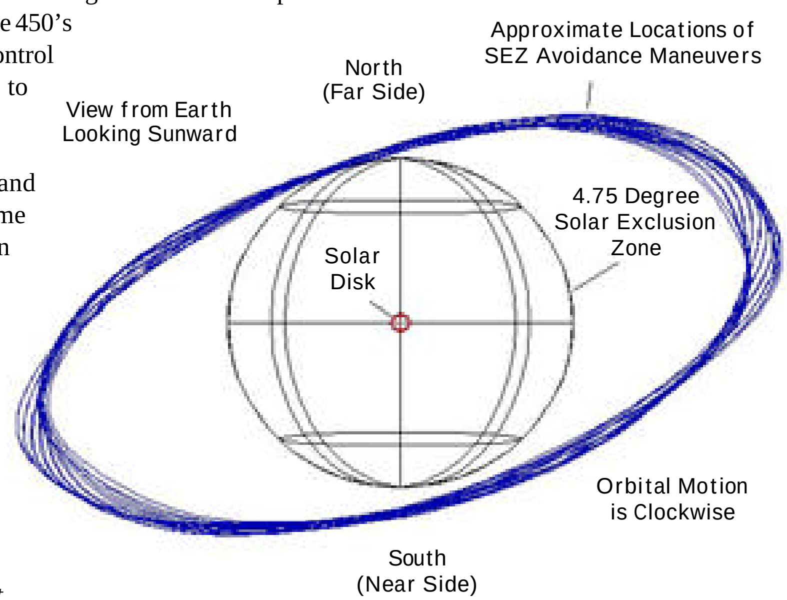


Figure 3. ACE Long Duration Lissajous with Z-Control Maneuvers
(View Looking Sunward)

Pacor-A Level-Zero Processing System Nears Implementation

GSFC's Science Data Processing organization continues its move toward automation and lights-out operations, with the approaching operational transition of the Pacor Automation (Pacor-A) system.

Following closely on the successful implementation of the SOHO Data Processing System (DPS) in January, and the RXTE DPS in May, the Pacor-A system will provide level-zero processing and related services for the Hubble Space Telescope (HST), Tropical Rainfall Measuring

(continued on page 20)

(continued from page 19)

(Mission (TRMM), Upper Atmosphere Research Satellite (UARS), and Earth Radiation Budget Satellite (ERBS) missions. Support for HST and TRMM was recently provided this summer, and UARS and ERBS are scheduled for transition later this year.

The Pacor-A system will reduce the cost of providing level-zero processing services to these legacy missions, and provide the basis for level-zero processing services to future missions. These goals will be accomplished by consolidating and automating the operations of these systems, and eliminating the custom hardware and aging computer systems currently in use. With the implementation of Pacor-A, many of the legacy systems currently supporting the HST, TRMM, UARS, and ERBS missions will be decommissioned.

For additional details regarding Pacor-A and the systems to be decommissioned, please see the article on this subject in the "Technology and Upgrades Project" section of this publication (page 22).

By Brian Repp/HTSI

Please contact the author via telephone (301-286-3699) or email (Brian.D.Repp.1@gsfc.nasa.gov) for more details.

User Planning System Automation Cuts ERBS Scheduling Time by 98%!

The User Planning System (UPS) project has made available the final version of Release 13. The UPS R13 Build 3 Version 2 software incorporates support of all new TDRS H, I, J services (S-band Multiple Access, Ka-band Single Access and Ka-band Single Access Wide Band), as well as support for flexible scheduling formats. The software also accepts a TDRS view data file (containing TDRS Scheduling Windows or TSWs), called the TDRS Communication Window (TCW) file.

The first UPS site to install Release 13, Build 3, Version 2 was the multimission UPS site, currently located in building 14 at GSFC. As of this date, Landsat 7 and the Hubble Space Telescope have also implemented Release 13 (Landsat 7 to R13 Build 1). Staff at the Mission Control Center at Johnson Space Center, which supports both the Space Shuttle and the International Space Station, are making final plans to migrate from UPS Release 11 to Release 13 very soon.

All multimission UPS customers (RXTE, TRMM, UARS, and ERBS) are using the new release to its full potential, reducing the number of schedule conflicts (requiring human intervention by both NCC and UPS staff) from an average of 30 per mission per week to about two per mission per week.

One of the shining success stories of UPS Release 13 concerns the ERBS mission. One of the oldest in NASA's "fleet," ERBS staff were spending 25 to 30 hours per week creating and "de-conflicting" its weekly SN schedule. Since ERBS is very low on the mission priority list, and the capability to submit flexible schedule requests was unavailable, some weeks several of ERBS requests were denied. Additionally, the potential for erroneous events was quite high, due to the large amount of human input and intervention required.

Realizing the potential for automating the highly complex, yet repetitious scheduling task, the ERBS project manager, Nihal Lenora, and the flight operations team (FOT) requested that the UPS staff investigate how to take full advantage of UPS to reduce the human labor required for scheduling.

In conjunction with the ERBS FOT, the UPS staff created a program at the ERBS Mission Operations Center (MOC) to accept ERBS TDRS view data and reformat it into the UPS-acceptable TCW format. The program, ERBSTCW, mimics the method the ERBS Scheduler uses to decide what TDRS views are available for scheduling. With the availability of TSW data in the UPS, the new UPS Recurrent Scheduling (RS) engine can then be used to create the 120 or so weekly flexible schedule requests for ERBS.

Since ERBS has been using the UPS RS engine to create requests:

1. The number of conflicts and unschedulable requests for ERBS has approached zero!
2. The time to create and "de-conflict" schedule requests has been drastically reduced—from 25-30 *hours*/week to approximately 30 *minutes*/week!
3. The potential for spacecraft endangerment through extended use of the ERBS battery, due to human error, is reduced.

By Howard Michelsen/CSC/CSOC

Further information regarding the UPS Project can be found on the WWW at http://kermit.gsfc.nasa.gov/isolde/ups/ or contact the author via email (hmichels@csc.com).

CODE 453

Technology and Upgrades Project

The
Technology and Upgrades Roadmap

"depicts technology developments and architecture upgrades that will be necessary to help guarantee that NASA's Space operations architecture effectively evolves to meet future customer needs."

A Word from the Technology and Upgrades Manager

The role of the Technology and Upgrades Project is to develop and infuse technology that will enable our present and future customers to achieve their missions. As a result, many exciting activities are underway in Code 453.

The Project consists of four complementary work areas:

- Architecture Evolution/System Engineering
- Technology
- Standards
- Upgrades.

Our goal is for every issue of *The Integrator* to contain articles with timely news from each of the four work areas. Both the Technology and Standards work areas are comprised of several subtasks. We plan to emphasize only one or two of these subtasks in each issue, rotating the topics covered so that each one appears at least once per year.

With a section entirely devoted to the Technology and Upgrades Project, the new format of *The Integrator* will allow us to more effectively communicate news of our activities and events with the space community. Please take the opportunity to read the articles in this section—the information they contain may be of interest to you or your customers!

Contact Roger Clason/Technology and Upgrades Manager via email (Roger.Clason@gsfc.nasa.gov) or telephone (301-286-7431) for additional information regarding this Project.

Code 450 Technology and Upgrades Roadmap in Development

Code 453, the Technology and Upgrades Project (TUP), has developed draft technology roadmaps for mission services, data services, and flight dynamics, illustrating the evolution of the space operations architecture for GSFC. The roadmaps are contained in a summary report document that will be distributed for review.

As described in the November 2000 and March 2001 issues of *The Integrator*, the roadmap depicts technology developments and architecture upgrades that will be necessary to help guarantee that NASA's space operations architecture effectively evolves to meet future customer needs. The roadmap will be used to provide direction for future GSFC technology investment.

The roadmap effort included an initial analysis of NASA Enterprise goals, future missions, and future customer needs. Targeting these future customer needs, TUP personnel identified mission and data service capabilities that must be achieved in order to meet the science and operational goals of future missions. Subsequently, the roadmap team created a series of diagrams to illustrate the connections between service capability developments and the future missions they enable. These roadmap diagrams were recently included in a summary report that details the roadmap development.

(continued on page 22)

(continued from page 21)

The next steps in the TUP roadmap effort are to distribute the technology roadmap summary report for review and feedback, and to coordinate the roadmaps with other forward-looking activities. These steps will ensure that the roadmaps reflect a coordinated Center-wide perspective on the evolution of the space operations architecture.

As work on the roadmap proceeds, look for additional information in future issues of *The Integrator.*

By Luis Tsuji/BA&H

For additional information, please contact Roger Clason/ GSFC Code 453 via email (Roger.Clason@gsfc.nasa.gov) or telephone (301-286-7431).

New Level Zero Processing System Will Cut Costs and Increase Efficiency

Major goals of the Space Operations Management Office (SOMO) and the Consolidated Space Operations Contract (CSOC) are to increase the efficiency, cost effectiveness, and quality of NASA's space operations services. Often, these objectives can be accomplished through consolidation, upgrades and modernization of legacy systems. NASA's level zero data processing systems are prime candidates for such improvements.

Currently, a number of separate systems provide level zero processing services to multiple ongoing missions, such as the Tropical Rainfall Measuring Mission (TRMM), Hubble Space Telescope (HST), Upper Atmosphere Research Satellite (UARS), and Earth Radiation Budget Satellite (ERBS). These systems involve expensive custom front-end hardware, are aging and therefore costly to repair, and require a great deal of human intervention to operate. CSOC is implementing the PACOR-A (Packet Processor II Automation) initiative to consolidate and automate these data systems, and to provide a method for supplying future missions with level zero processing services.

Under PACOR-A, a single new system will take the place of aging systems, including PACOR II, TDRSS Interface Preprocessor Into Telops (TIPIT), Generic Block Recording System (GBRS), Generic Recording System (GRS), SRS Scheduling System, and the Data Distribution Facility (DDF). Figure 1 shows the legacy systems used by each spacecraft that are slated for replacement by PACOR-A.

PACOR-A will provide the capture and archiving of raw telemetry data, generation of quick-look products, merging of data into level 0 production products, distribution of quick-look and level zero production products, and forwarding of near real-time data to customer facilities.

Work on PACOR-A is proceeding well. In fact, PACOR-A supported HST and TRMM in parallel with legacy systems from April 25 until June 13 of this year. An HST/TRMM Operational Readiness

PACOR-Automation Approach/ Functional Replacements

System	HST	TRMM	UARS	ERBS
GRS	X	X		
GBRS			X	X
Pacor II	X	X		
TIPIT			X	X
IBM LZP*			X	X
Clearpath*				X
DDF**	X	X		X

** Still required to support IMP8 after PACOR-A is operational.*

*** Has 2-year data retention requirement after PACOR-A is operational.*

Note: Small subset of GRS/GBRS hardware and software will need to be retained for raw data archive access.

Figure 1. Systems that will be replaced by PACOR-A. NASA will realize significant savings in labor and system sustaining and maintenance costs with implementation of PACOR-A.

Review was conducted successfully on June 13, 2001, and soon PACOR-A will become the sole level zero processing system for those two missions. UARS system testing is scheduled from June 11-July 19, and ERBS mission software is currently under development.

By Lena Braatz/BA&H

For additional information on PACOR-A development, please contact Betsy Tervo via telephone (301-794-2402) or via email (etervo@csc.com).

Space Network Web Services Interface Build 2 Complete

Software development of the Space Network (SN) Web Services Interface (SWSI) has been progressing well since the October 2000 Design Review. SWSI will provide a standards-based customer interface to the Network Control Center Data System (NCCDS) and the new Demand Access System (DAS). It will perform TDRSS customer scheduling, real-time service monitoring and control, and state vector storage. SN customers will be able to perform all these functions for only the cost of a desktop computer or workstation. A web browser and a Java virtual machine, both of which are freely available, will also be required.

SWSI access is available from both the NASA Integrated Services Network (NISN) IP Operational Network (IONET) and the Internet in a secure manner using digital certificates to authenticate remote customers and Secure Sockets Layer (SSL) protocol with strong encryption for data integrity and confidentiality.

SWSI uses state-of-the-art technology to interface with DAS to exchange data. The interface between SWSI and DAS is based on eXtensible Markup Language (XML). XML is a World Wide Web Consortium (W3C) endorsed standard for document markup. It defines a generic syntax to markup data with simple, human-readable tags. XML provides a standard format for computer-based communication between heterogeneous systems. It is a meta-markup language for text based data exchange. The tags in XML documents contain text markup that describes the data. The use of XML technology resulted in rapid development of SWSI/DAS interface software and added flexibility and extensibility to the interface.

Build 2 was completed on schedule on June 15, and provides a significant amount of the capability needed to perform customer scheduling of TDRS and DAS services. Using this build, SWSI customers are able to submit all types of schedule requests (Schedule Add Request, Replace Request, etc.) and can make full use of the flexible scheduling capabilities provided by the NCC 98 release. This build also implements an Open IONET version of the TDRSS Unscheduled Time (TUT) web server, allowing customers to query the NCCDS to determine available service time periods. This capability was previously provided by NCCDS only to customers connected via the Closed IONET. SWSI opens the TUT web service to access by customers connected via the Open IONET and Internet.

DAS scheduling capabilities are also provided in this build. DAS customers are able to determine service availability using the Resource Availability panel and to perform subsequent service scheduling using Resource Allocation Requests (RARs). Tracking of previously submitted requests is performed through the use of an integrated Schedule Request Summary panel, which includes requests for both the NCCDS and for DAS. An integrated Active Schedule Summary panel displays information about events that have actually been scheduled by NCCDS and DAS. The Active Schedule Summary panel is also used for selecting active services for reconfiguration using Ground Control Message Requests (GCMRs).

Interface testing with the Auxiliary NCC (ANCC) will begin in July 2001 with Build 2 Integration Testing. Development of the final build (Build 3) has begun and is scheduled for completion by November 2001, at which time final Acceptance Testing will begin. Transition to operations is scheduled for February 2002.

By Tom Sardella/GSFC Code 583 and Harshna Sampat/ CSC.

For further information, please contact Tom Sardella via email (Tom.Sardella@ gsfc.nasa.gov) or telephone (301-286-7686), or visit http:/ /msp.gsfc.nasa.gov/swsi.

Data Services Management Center Coming to White Sands

The Data Services Management Center (DSMC) was approved as a CSOC Integrated Operations Architecture (IOA) initiative in November 1999. The Program Commitment Document (PCD) outlines a plan to consolidate Space Network (SN) and Ground Network (GN) data services network management, thereby achieving cost savings in operations and sustaining activities. The PCD includes objectives to reduce duplication and overlap, and streamline processes to deliver data services—all while maintaining quality and reliability.

(continued on page 24)

(continued from page 23)

SN and GN management functions will be consolidated at the White Sands Complex (WSC) in Las Cruces, NM. Over the past year, we have implemented several steps to set this initiative in motion. For example, Network Control Center (NCC) GN Scheduling functions are already in place at the Wallops Scheduling Office, and portions of the NCC Technical Manager and Performance Analyst responsibilities have transferred to the WSC. The next major phase is the transition of GN scheduling to WSC, which includes relocation of the Wallops Orbital Tracking Information System (WOTIS).

WOTIS has been installed at the DSMC, and system testing is near completion. A phase of Operations Evaluation Testing (OET) which will include training, external interface testing (customers will be requested to participate), and parallel operations is planned. We are utilizing a phased approach to incorporate WOTIS operations at WSC. The scheduling function for the legacy GN systems is moving first, followed by automated GN systems, then Shuttle scheduling, and finally the Shuttle and Special Missions Planning function.

A customer communication meeting on the GN transition was held on June 25 to provide an overview of the effort. The meeting focused on the plan for legacy systems, and highlighted changes that will affect customers. A customer communications meeting to discuss the automated systems is planned for mid-August.

The other major component of the DSMC transition is the transfer of NCC systems and their associated operations activities. A suite of NCC equipment has been shipped to WSC, and is undergoing installation to be followed by system testing. A team will conduct NCC OET, including external interface testing with SN customer participation. We plan to accomplish the transition to the DSMC as a cutover (versus a phased failover); the transition will be functionally similar to what occurs during delivery of a new release to the NCC. A customer communications meeting regarding this transition is planned for later this summer.

In line with recent CSOC changes shifting responsibilities to the NASA centers, DSMC project management was moved from CSOC Central at JSC to GSFC effective June 18.

The following chart summarizes key milestone dates for the DSMC.

WOTIS	
WOTIS OET Start	6/25/01
WOTIS Legacy Systems Operational Readiness Review (ORR)	8/1/01
DSMC WOTIS Prime for Legacy Systems	8/9/01
WOTIS Automated Systems ORR	10/10/01
DSMC WOTIS Prime for Automated Systems	10/18/01
NCC	
NCC System Test Start	8/16/01
NCC OET Start	9/6/01
DSMC NCC ORR	2/6/02
DSMC NCC Prime	2/28/02
DSMC Auxiliary NCC ORR	6/20/02
DSMC Test and Training Suite/ SMTF Readiness Review	10/23/02

By Cathy Barclay/CSOC DSMC Project Manager

Please contact the author via telephone (301 805-3221) or email (Cathy.Barclay@ honeywell-tsi.com) to obtain more information on the DSMC effort.

WSC Data Services To Be Automated

One requirement of the Consolidated Space Operations Contract (CSOC) is to reduce costs to NASA for data services. The Data Services Automation (DSA) project is doing just that.

The idea behind DSA is to combine the functions of two console operations positions at the TDRSS White Sands Complex into one. Currently, these two positions include the Communication Services Controller (CSC), who is responsible for the operation, scheduling, and maintenance of one Space-to-Ground Link (SGLT) Terminal, and the Flight Operations Specialists (FOS), each of whom is responsible for the operations of two TDRS spacecraft. During the proposal process for CSOC, it was decided that these two functions could be combined into one position. In early 2000 a team of Engineers and Operations Specialists at the WSC started formulating requirements for this consolidation and constructing a design which would satisfy those requirements.

It was apparent from the start that the two positions could not be combined simply by eliminating half of the chairs in the control center. Operations staff conducted a detailed study of what tasks are performed by each position, the frequency of these tasks, and the duration of each. They developed a matrix of all of the tasks, allowing the Operations Specialists to determine which tasks might be eliminated or transferred to other positions. The remaining tasks were then totaled to determine how much work would be left for one operator to perform. The combined task list indicated 14 hours of work, per 8 hour shift, per operator. Obviously some changes were in order.

To streamline these activities, the Operations Specialists held a series of meetings with WSC Software Engineers in each of the major software areas. In these meetings, the group identified a series of tasks, which, if they were automated, would result in a significant reduction in the operator loading for the new position. Software Engineers then started designing changes to the software involved in each of these tasks, providing the needed automation to reduce the task loading, and generally improving the operations for the new position.

An outgrowth of these activities was the realization that the existing Console Workstations, DEC Vax 4000-60s, could not provide the necessary power to support both the automation of the position's tasks and the new requirements. WSC Hardware Engineers reviewed the available alternatives and selected the Compaq Alpha XP-900 workstation as the logical choice. These new machines are significantly more powerful and can be integrated into the existing Operations Computer Network easily, since they run the OpenVMS operating system. Each of the new console positions will receive three XP-900s to replace the two 4000-60 workstations. This will give the new operators a computing performance boost more than adequate for the task at hand.

In concert with the consolidation of the duties of the CSC and FOS positions, a new position has been created—the Satellite Controller (SATCON). The SATCON will have responsibility for overseeing TDRS Spacecraft Operations for the fleet and directing and conducting TDRS contingency operations. This position requires a number of new software functions, which the Software Engineering group is developing.

The requirement for expanded visibility into the whole of the WSC operations led to a change in the Video Distribution within and between the two TDRSS Operations Control Centers (TOCCs). Each of the console positions will have the capability of viewing the video displayed on any monitor at any of the consoles at either TOCC. Such intersite video is entirely new. Advances in video distribution technology since the early '90s have made possible a much higher performance system at considerably lower cost than the legacy system.

The final major engineering effort for WSC is the integration of the two backup command and telemetry systems into one platform. TDRS 1 through 7 use a system called the Realtime Command and Telemetry System (RCTS). For TDRS 8, I, and J, Spectrum-Astro developed a system for Boeing called the Remote Telemetry Monitoring System (RTMS). Since each system was developed independently for spacecraft whose command and telemetry formats are dissimilar, RCTS and RTMS differ quite a bit.

The RCTS runs as a DOS application under Windows 3.0. The software was developed locally, and a special command interface card provides the interface to the TT&C systems. The RTMS is a LabView application running under Windows NT. Command data is transferred to the TT&C systems via ethernet packets. The RCTS can be operated by a remote operator, the RTMS cannot.

The modifications for these systems consist of rewriting the RCTS code into the LabView system, writing a new Command driver function for F1-7, and providing new functions for the original RTMS code. The new combined platform will be known as RTMS2. We are replacing the original PCs delivered for use with RTMS with much higher-performance models to correct some performance lags in the delivered systems and to provide space for an additional I/O card.

To provide the SATCON access to all of the systems, a Keyboard/Mouse/Video (KVM) switch system is being installed. It will deliver video from any of the RTMS2 machines to the SATCON, and allow the SATCON to assume control of any of the RTMS2 platforms when necessary.

The KVM architecture was selected over a LAN-based architecture for the RTMS2 connectivity solution for a number of reasons. First and foremost, there will be no software development required for this scheme, as the KVM solution is entirely hardware based. Second, the KVM solution provides the capability to have both of the legacy systems in use until the RTMS2 coding and testing are complete, enabling the DSA project to be operational sooner. Finally, since the RTMS2 interface for TDRS 8, I, and J uses a Network Interface Card (NIC) for its spacecraft command interface, and LabView does not support more than one NIC in any one machine, a LAN architecture would have had to share with the command interface, leading to bandwidth issues.

DSA is one of the Integrated Operations Architecture (IOA) projects which was part of the original CSOC contract bid. Operational Readiness for DSA is currently scheduled for summer 2002. If staffing projections prove out, NASA should save over $6,000,000 through FY 2008, with positive savings (cost savings minus project cost) beginning in the fourth quarter of 2003.

By Harlan McKay/WSC

To learn more about the DSA effort, contact the author at (505) 527-7143.

DAS Will Feature:

DG 1 Mode MA Return Services

ON-DEMAND Service for Dedicated Users

Scheduled Service for Non-Dedicated Users

SWSI-Based User Planning & Scheduling Interface

Fully Automatic:
Beamforming
Demodulation
Telemetry Data Formatting
Telemetry Data Distribution
Telemetry Data Short-Term Storage

CCSDS Telemetry Processing Available
Frame Synchronization
Reed Solomon Decoding
Virtual Channel Processing
Virtual Channel Segregation

Telemetry Encapsulation Available for TCP/IP Transport
Standard Formatted Data Unit
AXAF-I SFDU
ACE SFDU
LEO-T
IPDU
Simple TCP/IP

Demand Access System Operational Next Year

The Demand Access System (DAS) is on target for a first quarter 2002 delivery into operations.

ITT built the DAS production beamformers, which are being integrated in the contractor's test facility in Reston, VA. ITT engineers are also developing DAS demodulator groups (DMGs) in the same facility and have built and tested several of them. Testing of a demodulator with actual customer signals is planned for August 2001 at the White Sands Complex (WSC).

DAS software will consist of approximately 36,000 source lines of code, mostly in C++. The software development effort is about 20% complete.

The customer interface for scheduling and managing DAS services is the Space Network Web Scheduling Interface (SWSI). SWSI development is proceeding on schedule, and DAS/SWSI integration testing is scheduled for late this year. For more about SWSI, please read the article on page 23. Customer and SWSI interface control documents are substantially completed.

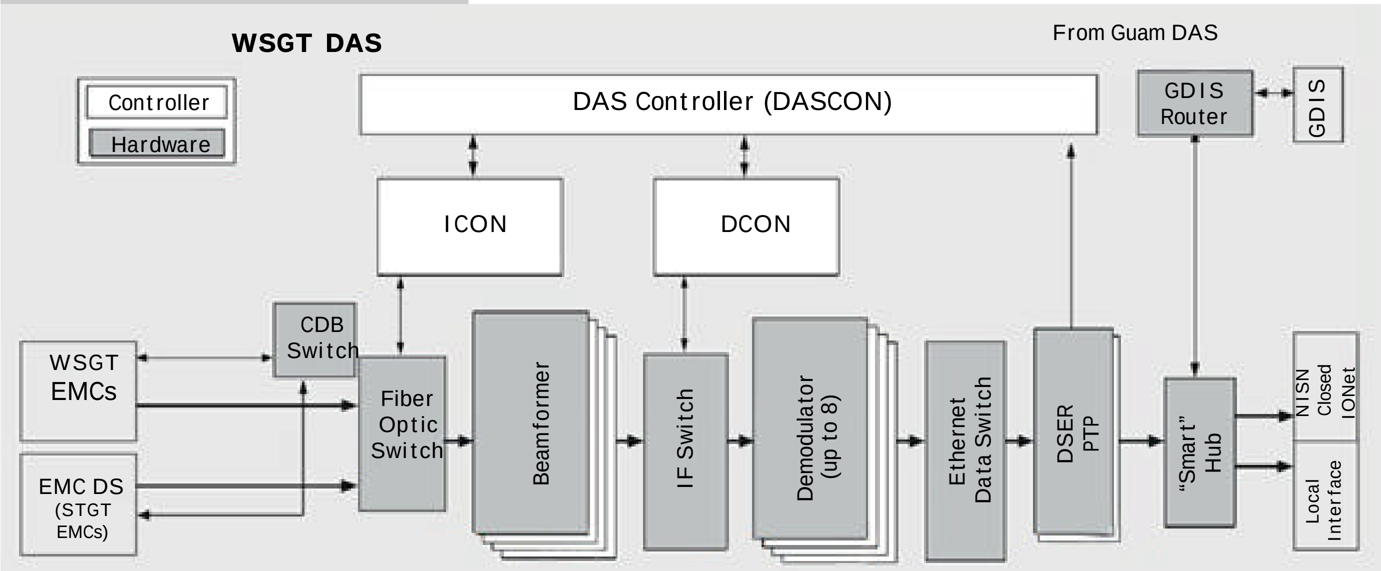
CSOC personnel are readying the WSC for DAS installation. They have delivered software changes at WSC and are procuring maintenance and development tools.

The upcoming revision (Rev. 8) of the Space Network User's Guide will contain an appendix describing DAS.

The DAS effort is being chronicled at *http://stelwscpo.gsfc.nasa.gov/das/*.

By Tom Gitlin/GSFC Code 453

For additional information, please contact the author via email (tom.gitlin@gsfc.nasa.gov) or telephone (301-286-9257).



WSC Element Multiplexer Correlators (EMCs) distribute multiplexed TDR spacecraft MA antenna element data via fiber optic lines to compact beamformers. The beamformers electronically steer a beam to a customer, and send information to compact demodulators, which recover the digital telemetry data. The demodulators, in turn, send data to Packet Telemetry Processors (PTPs). The PTPs process data and send it on to customers via the NISN Closed IONet.

GSFC Active in CCSDS Panel 1 Activities

The Consultative Committee for Space Data Systems (CCSDS) is an international organization, whose members seek to exchange technical information regarding common space data transport and information interchange problems. CCSDS members work to agree upon optimized solutions (called CCSDS Recommendations) to such problems, and to promote the implementation of these solutions.

In this article, we will discuss the recent activities of CCSDS Panel 1. Panel 1 is specifically chartered to investigate Telemetry, Tracking, and Command. Its main objectives are to identify the physical link characteristics, data structures and protocols at the space link interface and develop associated technical recommendations to maximize opportunities for cooperation, thereby achieving space mission data interoperability. The following chart lists the Panel 1 teams on which GSFC personnel serve, the subject area of each subpanel, and points of contact for each team.

Subpanel	Subject Area	GSFC Point of Contact
1A	Development of Data Link Protocols	James Pritchard/Code 586 Tim Ray/Code 584
1B	Channel Coding	Pen-Shu Yeh/Code 564 Wai Fong/Code 564
1C	Data Compression	Pen-Shu Yeh/Code 564
1E	RF and Modulation	Badri Younes/Code 450 Wai Fong/Code 564
1F	Advanced Orbiting Systems	James Pritchard/Code 586 Tim Ray/Code 584
1J	Navigation	Felipe Fores-Amaya/Code 572
1K	Spacecraft onboard Interfaces	Richard Schnurr/Code 560

GSFC personnel supported the Fall 2000 and the Spring 2001 CCSDS meetings. There the subpanels worked on updates to the CCSDS "Blue Books," which contain recommendations that the CCSDS has adopted, and discussed the publication of "Green Books" (also called CCSDS Reports). They also reviewed content of various "Red Books" which contain draft CCSDS recommendations. During these discussions, members suggested alternative proposals for recommended procedures and standards, finalizing decisions by vote.

In addition, GSFC members participated in Technical Steering Group (TSG) activities. The TSG is a CCSDS-wide group that meets twice a year to discuss various organizational and technical issues, as well as new work proposals. The TSG also makes recommendations to the Management Council. The TSG recently approved a resolution by Subpanel 1F to hold a CCSDS Interoperability Workshop in the Fall of 2001, and approved a proposal for developing "Ranging and Timing Services" which could involve all panels. The TSG also agreed that a section on Security should be included in each new Blue Book published, and recommended that the investigation regarding development of a new system architecture for the CCSDS Web Site continue.

IN REMEMBRANCE:

Special appreciation is expressed to Warner H. Miller (GSFC/Code 564) for his vision and effort in initiating standardization of compression algorithms, and his many contributions to the CCSDS program. The CCSDS Telemetry Channel Coding Blue Book will be dedicated to Warner H. Miller.

By Felipe Flores-Amaya/Code 572

For more information on the CCSDS itself, please visit the CCSDS home page at http://www.ccsds.org/.

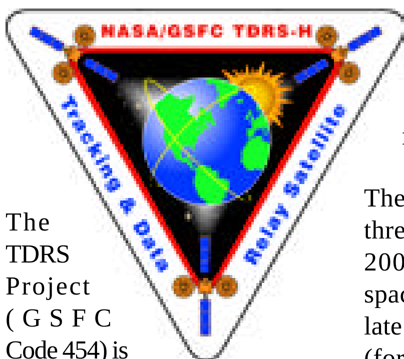
To learn more about GSFC participation in the CCSDS, contact the author via email (fflores@pop500.gsfc.nasa.gov) or telephone (301-286-9068).

CODE 454

TDRS Project

The TDRS Project: Ushering in the Next Era of Space Communications

"Currently, Code 454 personnel are focusing on final testing and launch preparations for TDRS-I, which is scheduled for a nighttime launch, October 29, 2001 from Cape Canaveral, FL, onboard an Atlas IIA rocket."

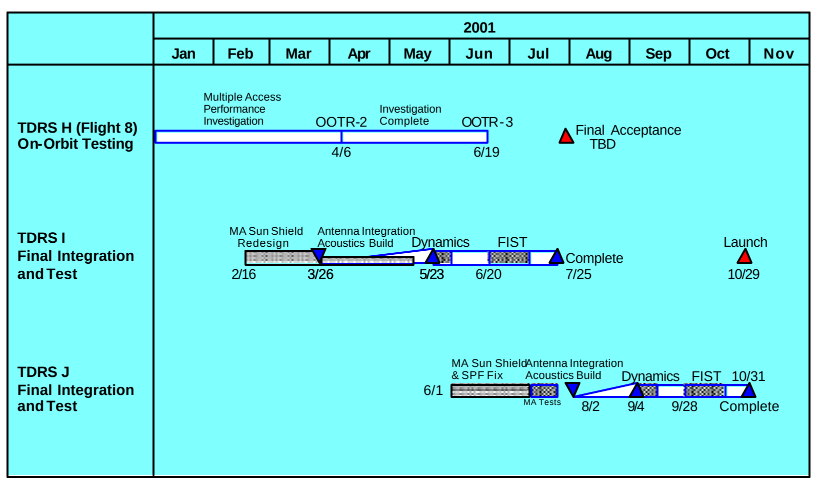


The TDRS Project (GSFC Code 454) is responsible for the development of three replenishment satellites designed to augment the fleet of TDRS spacecraft currently supplying many of NASA's space communications requirements. These new satellites, termed TDRS H, I, and J, are being produced in a multi-phased effort. The Project is comprised of a dedicated, hard working and very talented set of individuals. More importantly, their collective efforts are essential to ensure the success of the TDRS H, I, and J mission and are greatly appreciated.

The Project staff continues to work on various aspects of all three satellites concurrently. After a successful launch in June 2000, the TDRS-H satellite underwent extended on-orbit spacecraft testing and checkout, which were completed in the late spring of 2001. NASA and Boeing Satellite Systems, Inc. (formerly Hughes Space and Communications) are currently working to reach a final acceptance disposition of TDRS-H.

In parallel with the on-orbit checkout of TDRS-H, Code 454 staff have been overseeing the development of TDRS-I and –J. Project members learned much from the TDRS-H launch and on-orbit checkout processes, and are applying these lessons to the TDRS-I and –J spacecraft.

Currently, Code 454 personnel are focusing on final testing and launch preparations for TDRS-I, which is scheduled for a nighttime



Forecast Schedule for TDRS H, I, J
(as of 6/13/01)

launch, October 29, 2001 from Cape Canaveral, FL, onboard an Atlas IIA rocket. Soon, the TDRS Project team will escalate final testing activities for TDRS-J, and prepare the spacecraft for storage in anticipation of its launch in October 2002.

Although the TDRS H, I, J Replenishment Program is in its prime, NASA has already begun thinking about the need for additional data relay spacecraft to maintain the Space Network even further in the future—from 2010 and beyond.

Please read more about the details concerning the TDRS Replenishment Program in subsequent articles in this section.

For additional information, please visit our web site at http://tdrs.gsfc.nasa.gov/Tdrsproject/, or contact Robert W. Jenkens via email (Robert.W.Jenkens.1@gsfc.nasa.gov) or via telephone (301-286-8034.

June 2000 launch of the TDRS-H spacecraft. TDRS-I will also utilize an Atlas Centaur IIA vehicle for launch, but will be launched at night on October 29, 2001.

Atlas Centaur IIA To Launch TDRS-I

The TDRS-I spacecraft is currently scheduled for launch on a Lockheed Martin Corporation Atlas Centaur IIA launch vehicle from Space Launch Complex (SLC) 36A at the Cape Canaveral Air Station (CCAS) on October 29, 2001. The components of the Atlas Centaur IIA launch vehicle are currently being manufactured at Lockheed Martin facilities in Denver, Colorado and Harlingen, Texas. These components will be shipped to Florida when completed in August, and assembly on the launch pad at SLC-36A will begin in early September.

The spacecraft will be flown from Los Angeles, California on a military aircraft to the Kennedy Space Center (KSC) in late September and moved to the Spacecraft Assembly and Encapsulation Facility 2 (SAEF-2). Final checkout of the spacecraft and propellant loading will be performed by Boeing Satellite Systems (BSS) personnel at SAEF-2. The spacecraft will then be encapsulated in the Atlas Centaur payload fairing and transported to SLC-36A. The encapsulated spacecraft will be mounted on the launch vehicle and final preparations for launch will begin.

On launch day, the Atlas Centaur will fly a standard ascent profile. The launch vehicle will lift off from the launch pad at SLC-36A using the Rocketdyne MA-5A engine system, which utilizes one sustainer and one dual chamber booster engine generating a total rated thrust of 2,180kN (490,000 lb). The MA-5A engines use RP-1 fuel and liquid oxygen as propellants. About 168 seconds from liftoff, the booster engine will be shut down, and the booster engine section jettisoned from the launch vehicle. The flight will continue with the remaining sustainer engine firing on the booster. The payload fairing will separate from the launch vehicle approximately 217 seconds after liftoff. The sustainer engine will burn until booster propellants are depleted, about 275 seconds into the flight.

The Centaur second stage will separate from the booster a few seconds later, and the Pratt and Whitney RL10A-4-1 engine system will ignite for the first time. The Centaur engines burn liquid hydrogen and liquid oxygen and generate 97.86 kN (22,000 lb) of thrust. The first Centaur burn will last about 293 seconds. The Centaur engines will be ignited a second time about 1,488 seconds into the flight to insert the TDRS-I spacecraft into a subsynchronous transfer orbit. Centaur engine cutoff will occur about 80 seconds later.

The Centaur will then maneuver into the proper attitude for spacecraft separation and spin up to 5 rpm. TDRS-I will be separated from the Centaur approximately 1,795 seconds after liftoff. After the spacecraft is separated, the Centaur will perform a contamination and collision avoidance maneuver (CCAM) to prevent additional contact with the spacecraft, and minimize the possibility of any contamination of the spacecraft with Centaur attitude control system exhaust products. The TDRS-I liquid apogee motor (LAM) will fire a series of burns to insert the spacecraft into the final synchronous mission orbit.

By Mike Goeser/GSFC, Code 703

For more information on this topic, please contact the author via email at Francis.M.Goeser.1@gsfc.nasa.gov or via telephone at (301) 286-0427.

TDRS-I Spacecraft Undergoes Final Testing and Launch Preparation

The TDRS-I spacecraft is currently located at the Boeing facilities in El Segundo, CA, and is being prepared for the October 2001 launch. Recently, Boeing engineers successfully completed a set of environmental tests (thermal vacuum, vibration, and acoustic tests) on the spacecraft. TDRS-I is now undergoing Final Integration System Testing (FIST), which is scheduled for completion in late July.

After FIST, the spacecraft will undergo the flight finalization process, where the spacecraft is mechanically configured for launch. During this process, grounding checks are performed, flight ordnance is installed, and the thermal blankets are properly attached to ensure they do not interfere with deployables such as the Single Access Antennas (SAA). The solar wings, which were removed after vibration testing to allow for deployment tests of the Space-Ground Link (SGL) and Forward Omni antennas, will be reinstalled, and electrical verification tests and squib continuity tests will be performed. Engineers will determine the mass properties of TDRS-I and "spin balance" the spacecraft. Finally, in late September, TDRS-I is scheduled for shipment to Kennedy Space Center for launch on an Atlas Centaur IIA.

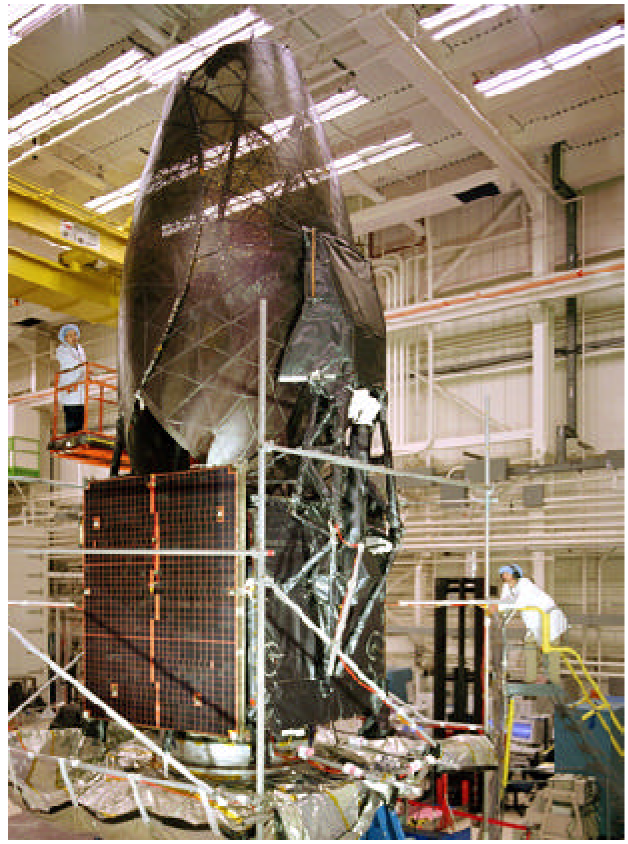
Like its sister satellites TDRS-H (launched in June 2000) and TDRS-J (launch date currently scheduled for launch in October 2002), TDRS-I incorporates new features that will enhance the aging TDRS constellation already in existence. The TDRS-H, I, J spacecraft make use of an innovative SAA reflector design. The two large SAAs are folded like a taco for launch to make efficient use of launch vehicle fairing space, and then unfurled early in the geosynchronous transfer orbit to allow them to "spring back" to their correct shape. This cost-effective "spring back" antenna design successfully enabled the replenishment TDRS to incorporate antennas with the specifications required to support S-, Ku-, and Ka-band communications.

The single access reflectors on TDRS H have been successfully tested on-orbit, and fully meet the specifications for Ka-band operations, offering customers a significant increase in the available throughput. The Ka-band frequency is also compatible with the frequencies utilized by many Japanese and European spacecraft, and therefore the Mission Services Program will have the opportunity to expand its customer base with this new capability.

TDRS-I differs from its predecessor TDRS H in one respect—engineers have modified the sun shield that protects the multiple access phased array antenna elements. This new design has been verified to assure that the sun shield will provide the necessary thermal and electrostatic discharge protection.

As the launch date for TDRS-I rapidly approaches, both Boeing and NASA staff continue to work to ensure the spacecraft is ready to launch.

To learn more, contact Jeff Gramling via telephone at (301) 286-6652,or via email at Jeffrey.J.Gramling.1@ gsfc.nasa.gov.



The TDRS-I spacecraft situated on the vibration table at the Boeing facilities in El Segundo, CA. Photo courtesy of Boeing Satellite Systems, Inc.

Networks Prepare for TDRS-I

Activities are underway to prepare the network and mission operations resources to support the upcoming launch of the Tracking and Data Relay Satellite System (TDRS) –I spacecraft in October 2001. During the next three months, supporting personnel and facilities will be conducting test and training activities to verify the readiness of control centers and tracking facilities located around the world. Two comprehensive mission rehearsals are currently scheduled for July and September to prepare the mission teams for the TDRS-I operations.

The spacecraft development contractor, Boeing Satellite Systems (BSS), also has the primary responsibility for all satellite operation activities, concluding with government acceptance after demonstrating operations with Space Network target of opportunity customer spacecraft. In addition to the BSS contractor team, the TDRS-I mission will receive support from operations personnel and facilities provided by Consolidated Space Operations Contractor (CSOC) teams located at the White Sands Complex (WSC) in New Mexico; the Goddard Space Flight Center (GSFC) in Greenbelt, Maryland; the Jet Propulsion Laboratory (JPL) in California; and Deep Space Network (DSN) Tracking Stations.

The TDRS-I mission sequence will be essentially the same as that successfully employed during the TDRS-H mission last year. Following separation from the Atlas IIA launch vehicle, the BSS Mission Control Center (BMCC) in El Segundo, CA will direct and monitor all satellite activities. The BMCC performs all satellite commanding via the DSN/Ground Network (GN) from the time of separation through transfer orbit, appendage deployments, and acquisition of earth pointing (approximately 5 days). Primary telemetry and tracking support during the transfer orbit and deployment mission phases are to be provided by the three 26-meter tracking antennas located at Goldstone, CA; Madrid, Spain; and Canberra, Australia. The 9-meter antennas located at Wallops Island, VA; Merritt Island, FL; and Santiago, Chile will be used to supplement the DSN coverage. The USAF tracking facility at Diego Garcia located in the Indian Ocean provides the BMCC with the first post-separation telemetry contact. Network data flow tests and operations training exercises between these facilities and the BMCC will be conducted throughout the summer months to bring the TDRS-I support teams to a state of readiness for the transfer orbit operations.

Following a series of perigee and apogee burn maneuvers to circularize and raise the apogee to geosynchronous altitude, the control center located at WSC will take over control and monitoring responsibilities from the BMCC. The Space Ground Link Terminals at WSC will be used during this phase of the mission by the test team to perform payload on-orbit testing. The payload testing is performed at 150 degrees West longitude, and includes communications payload and antenna calibrations, compatibility tests with the WSC ground systems, and Space Network end-to-end testing. After successful completion of the payload test phase at WSC (about 60 days), the satellite will be ready to be relocated to an operational longitude between 40° West longitude and 175° West longitude to complement the existing fleet of TDRS satellites, and sustain the Space Network communications capability through the year 2010.

By Ed Lowe/GSFC Code 454

For additional information, please contact the author via email (Edward.T.Lowe.1@gsfc.nasa.gov) or via telephone (301-286-6664).

TDRS Resident Office Monitors Progress for TDRS Project

The Prime Contractor on the TDRS H, I, J Contract is Boeing Satellite Systems (BSS), which is located in El Segundo, California [El Segundo is just south of the Los Angeles International Airport (LAX)]. The TDRS H, I, J Contract requires BSS to provide office facilities and office support for a NASA/TDRS Resident Office.

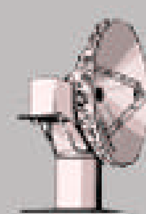
The primary mission of the TDRS Resident Office (RO) at BSS in El Segundo is to act as the real-time eyes and ears of Code 454, and to relay to the TDRS Project the observations collected by those eyes and ears. Secondary activities include (1) test data analysis and trending of Spacecraft test data; (2) coordination with NASA for visitors to BSS; (3) provision of System Engineering and technical support services to the Project; (4) witnessing certain critical tests and functions, including verification of Payment Milestone Completions; and (5) establishing and maintaining an extensive library of TDRS H, I, J technical documents.

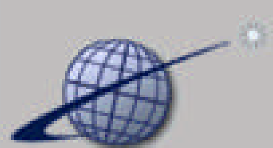
The TDRS RO engineering staff includes Bing Joe as the Bus Engineer, while Steven Keller and Don Neudecker are the two Payload Engineers. Paul Nordin doubles as the RO Manager and as a System Engineer. Willie Bostic performs the Quality Assurance function, while Tonni Hemphill is our indispensable and helpful Administrative Assistant.

By Paul Nordin/TDRS Resident Office

For more information, please contact the author via email (Paul.Nordin@HSC.com) or via telephone (310-364-7405).

Members of the NASA TDRS Resident Office staff include (from left to right) Steven Keller, Donald Neudecker, Bing Joe, Paul Nordin, Tonni Hemphill and Willie Bostic.





The Integrator

can be accessed on line at
http://msp.gsfc.nasa.gov/integrator/.

Previous issues of the newsletter can also be found on line in *The Integrator* Archive.

If you have questions, comments, or suggestions for *The Integrator* newsletter, please contact:

Lynn Myers via
E-mail (lynn.myers@gsfc.nasa.gov)
Phone (301-286-6343) or
Fax (301-286-1724)

Edited By:
Lena Braatz (Booz·Allen & Hamilton)

Layout & Illustration By:
Sherri Tearman (Booz·Allen & Hamilton)